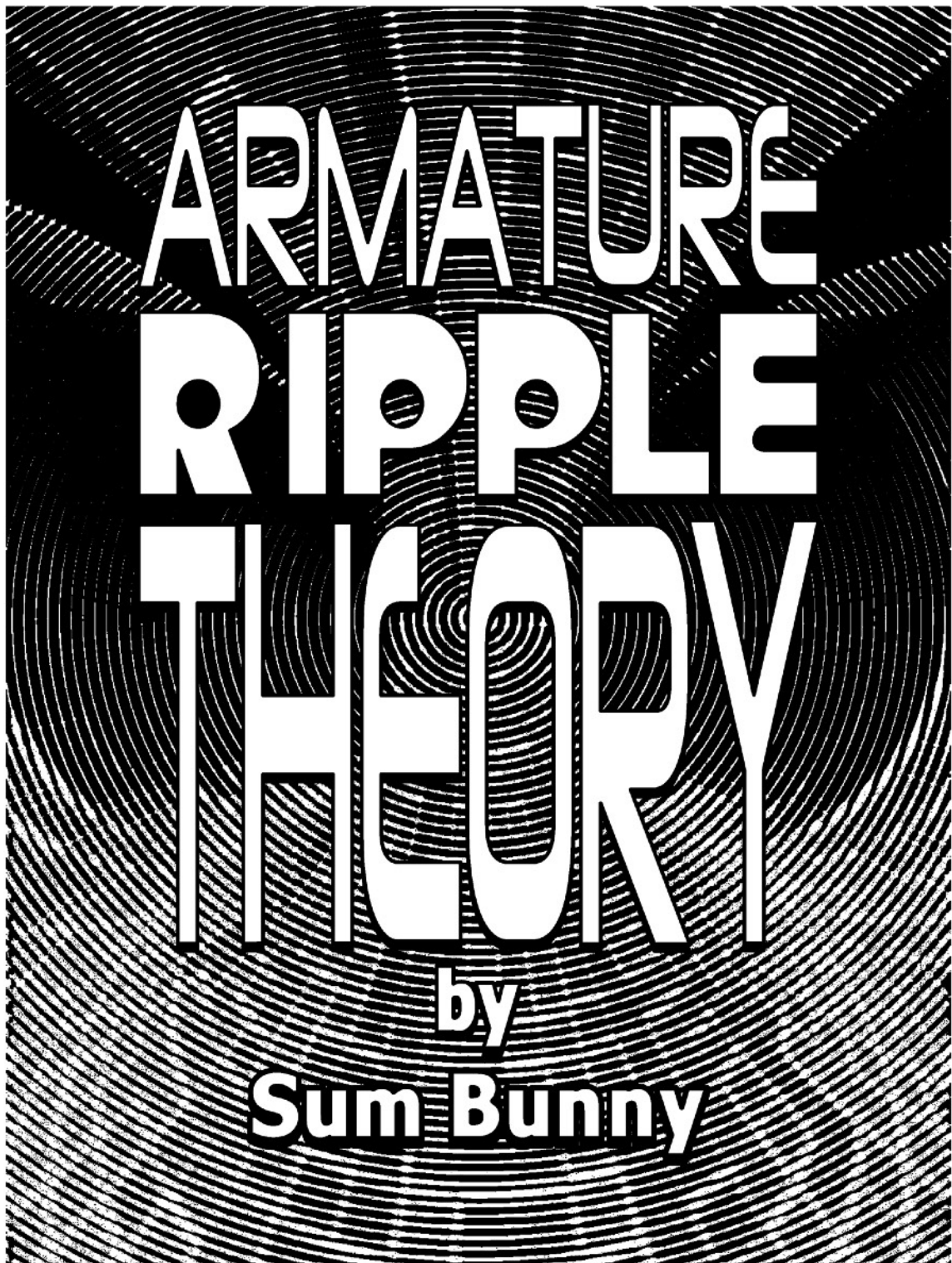




ARMATURE RIPPLE THEORY

A Minimal Scalar-Gauss-Bonnet Model

Sum Bunny

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ARK HIVE PRESS

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ARMATURE RIPPLE THEORY (ART)

A Minimal Scalar-Gauss-Bonnet Model

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Prologue: Curvature and Its Signatures

Strong gravity exposes the internal structure of spacetime.
When curvature rises, the underlying grammar becomes visible.
Armature Ripple Theory isolates one form of this grammar:
a minimal interaction between a scalar field and the Gauss-Bonnet invariant
that alters how horizons behave.

ART does not seek to replace General Relativity.
It isolates the smallest deviation that changes the signature of a black hole
without disturbing the wider coherence of the universe.

1. Minimal Structure

ART introduces a single real scalar field ϕ interacting with the Gauss-Bonnet invariant G .

The action is:

$$S = \int \sqrt{-g} \left[(M_{\text{Pl}}^2 / 2) R - (1/2)(\partial\phi)^2 + (\lambda / M^2)(\phi^2 / 2)G \right].$$

The theory contains:

- one scalar field with a canonical kinetic term,
- a single dimensionless coupling λ ,
- one curvature interaction,
- no potential and no additional fields.

The theory belongs to the ghost-free scalar-Gauss-Bonnet class.
It propagates two tensor modes and one scalar mode.

2. Curvature-Induced Mass

The scalar satisfies:

$$\square\varphi + (\lambda / M^2) \varphi G = 0.$$

This can be written as:

$$\square\varphi - m^2_{\text{eff}} \varphi = 0,$$

with

$$m^2_{\text{eff}} = - (\lambda / M^2) G.$$

In weak curvature, $m^2_{\text{eff}} \approx 0$ and the scalar remains quiescent.

Near a Schwarzschild horizon, $G > 0$ produces a region where:

$$m^2_{\text{eff}} < 0 \text{ (for } \lambda > 0 \text{)}.$$

This initiates a curvature-driven instability.

3. Spontaneous Scalarization

When m^2_{eff} becomes negative, $\varphi = 0$ is no longer stable.

The field grows and forms a static scalar profile around the black hole.

This process is spontaneous scalarization.

Scalarization modifies:

- horizon structure,
- energy extraction channels,
- tidal heating,
- quasi-normal-mode frequencies.

These effects remain local to the strong-gravity region.

4. Armature Ripples

A scalarized black hole supports oscillatory modes that couple scalar and tensor fluctuations.

These horizon-scale oscillations alter the ringdown waveform.

The signature appears as:

- shifted QNM frequencies,
- modified damping times,
- scalar-tensor mode mixing arising from the coupled perturbation equations.

Typical deviations satisfy:

$$\Delta\omega / \omega \approx 10^{-4} \text{ to } 10^{-2},$$

placing them within reach of next-generation observatories.

These oscillations are the **Armature Ripples**:
a structural modulation of the horizon produced by the curvature-scalar interaction.

5. Cosmology and Constraints

In a flat FRW universe:

$$G_{\text{FRW}} = 24 H^2 (\dot{H} + H^2).$$

The scalar evolves according to:

$$\ddot{\phi} + 3H \dot{\phi} + (\lambda / M^2) \phi G_{\text{FRW}} = 0.$$

Mild time evolution of ϕ modifies the effective Newtonian coupling:

$$G_{\text{eff}} = G / [1 + \alpha \phi^2], \text{ where } \alpha \propto \lambda/M^2.$$

Observations constrain the rate of change:

$$|\dot{G} / G| < 10^{-12} \text{ per year.}$$

These bounds apply to the **combination** of λ/M^2 and the present-day scalar roll $\dot{\phi}(t)$.
Slow evolution at late times places ART inside the observational window without requiring fine-tuning.

The gravitational-wave speed remains observationally safe when $\dot{\phi}$ today is sufficiently small.

ART does not generate cosmic acceleration and does not replace dark matter.
Its macroscopic effects remain limited to strong gravity and mild cosmological modulation.

6. Minimal Predictions

ART predicts three testable phenomena:

1. Black-hole scalarization

A horizon-scale tachyonic instability for $\lambda > 0$.

2. Armature Ripples

Distinct deviations in ringdown modes from scalar-tensor coupling.

3. Mild variation of G_{eff}

A small curvature-driven correction observable through precision timing.

These predictions provide a clear path to confirmation or exclusion.

7. Purpose and Position

ART is a minimal geometry:

a single scalar, a single coupling, a single consequence.

It isolates one mechanism through which curvature imprints structure on a horizon without disturbing the stability of the larger universe.

As a companion to the Universal Basic Equation,
ART stands as a focused inquiry into strong-gravity grammar—
a demonstration of how little must change
for a black hole to produce a new signature.

Appendix: Essential Equations

Scalar equation: $\square\varphi + (\lambda / M^2) \varphi G$

Effective mass: $m^2_{\text{eff}} = -(\lambda / M^2) G$

Scalarization condition: $\lambda > 0$ and $G > 0$

FRW curvature: $G_{\text{FRW}} = 24 H^2(\dot{H} + H^2)$

Effective Newton coupling: $G_{\text{eff}} = G / [1 + \alpha \varphi^2]$

APPENDIX Z – NOTES ON AI ASSISTANCE

AI tools were used in a limited capacity for proofreading, compression, and structural review. These tools did not originate the theoretical content presented here.

Responsibility for the arguments, claims, and conclusions rests solely with the author.

Acknowledgment

In appreciation of **Josiane**,
whose intelligence and kindness
restored balance when it was needed most.

$$\begin{array}{c} 0 \\ n \\ \boxed{\odot} m^2 \phi + - G \\ M^2 \\ = \end{array}$$

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